

EXAMPLE OF LIMITATION OF 2/3 SMF

1. The following example will demonstrate that if β is large compared to ϕ (the ratio $\tan \beta / \tan \phi > 0.56$), the value of the horizontal earth pressure coefficient computed from Coulomb's equation using an SMF of 2/3 will exceed the value of the horizontal pressure coefficient computed from the Danish Code equation. In some cases, this increase will be overly conservative.

2. For a smooth (no wall friction), vertical wall with a soil having $\phi = 30^\circ$ and $\beta = 21^\circ$, the horizontal earth pressure coefficients will be computed by the Danish Code equation and Coulomb's equation.

Danish Code Equation (Equation 3-5, EM 1110-2-2502)

$$\begin{aligned} K_o &= (1 - \sin \phi)(1 + \sin \beta) \\ &= (1 - \sin 30^\circ)(1 + \sin 21^\circ) \\ &= 0.6792 \end{aligned}$$

Coulomb's Equation with SMF = 2/3 (Equation 3-14, EM 1110-2-2502)

$$\begin{aligned} \phi_d &= \tan^{-1} (\text{SMF} \tan \phi) \\ &= \tan^{-1} (2/3 \tan 30^\circ) \\ &= 21.0517^\circ \end{aligned}$$

$$\begin{aligned} K_o &= \frac{\cos^2 \phi_d}{\left[1 + \sqrt{\frac{\sin \phi_d \sin (\phi_d - \beta)}{\cos \delta \cos \beta}} \right]^2} \\ &= \frac{\cos^2 21.057^\circ}{\left[1 + \sqrt{\frac{\sin 21.0517^\circ \sin (21.0517^\circ - 21^\circ)}{\cos 21^\circ}} \right]^2} \\ &= 0.8394 \end{aligned}$$

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Coulomb's Equation with SMF = 0.7319 (from Table in Enclosure 5 for $\phi = 30^\circ$)

$$\begin{aligned}\phi_d &= \tan^{-1} (\text{SMF} \tan \phi) \\ &= \tan^{-1} (0.7319 \tan 30^\circ) \\ &= 22.9071\end{aligned}$$

$$\begin{aligned}K_o &= \frac{\cos^2 22.9071^\circ}{\left[1 + \sqrt{\frac{\sin 21.0517^\circ \sin (22.9071^\circ - 21^\circ)}{\cos 21^\circ}} \right]^2} \\ &= 0.6791\end{aligned}$$

3. From the summary of the results below, Coulomb's equation with an SMF of 2/3 results in an at-rest earth pressure coefficient which exceeds the Danish Code equation.

At-rest, Danish Code equation:	$K_o = 0.6792$
Coulomb's equation with SMF = 2/3:	$K_o = 0.8394$
Coulomb's equation with SMF = 0.7319:	$K_o = 0.6791$